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ABSTRACT

Children's ability to recognize unfamiliar faces shows an unusual developmental trend: performance improves from 6 to 11 years, a temporary regression occurs at 12 years, and then recovery leads to adult-level performance. The first study described in this paper tested 80 children 5 to 11 years of age on a face-matching and recognition task. Results showed that age differences in face recognition are a function of encoding ability at acquisition and cannot be attributed to an age-related improvement in recognition or storage skills. Using a sample of 271 children 7 to 16 years old, the second study examined the effect of orientation on face recognition and found an inversion effect for children under 10 years and a significant improvement in performance for both upright and inverted faces. This finding updates earlier results and indicates the following: (1) general pattern encoding skills contribute to the recognition of upright faces; and (2) young children's face encoding is orientation-sensitive. Using a sample of 142 children from primary 3, 6, and 7 classes and senior 1, 2, and 4 classes, the third study assessed the generality of the unusual regression at 12 years and found that a similar "dip" in performance also occurs for children's recognition of pictures of houses. These data suggest that children's recognition of faces and pictures may be essentially similar processes. The finding of a dip in children's picture recognition adds to a growing catalog of similar developmental regressions. Possible explanations for this temporary loss of ability are discussed. (Author/RH)

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The Ups and Downs of Face Recognition

A Unique Developmental Trend?

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ABSTRACT

Children's ability to recognize unfamiliar faces shows an unusual developmental trend, performance improves from 6 to 11 years, followed by a temporary regression at 12 years, and then recovers to adult level.

Study (1) tested children (5 - 11 years) on a face matching and recognition task. Results showed that age differences in face recognition are a function of encoding ability at acquisition and cannot be attributed to an age-related improvement in recognition or storage skills.

Study (2) examined the effect of orientation on children's (7 - 16 years) face recognition and found an inversion effect for children under 10 years plus a significant improvement in performance for both upright and inverted faces. This updates earlier findings and indicates a) the contribution of general pattern encoding skills to recognition of upright faces; b) that young children's face encoding is orientation-sensitive.

Study (3) assessed the generality of the unusual regression at 12 years, and found that a similar 'dip' in performance also occurs for children's recognition of pictures (houses). These data suggest that children's recognition of faces and pictures may be essentially similar processes.

The finding of a 'dip' in children's picture recognition adds to a growing catalogue of similar developmental regressions. Possible explanations for this temporary loss of ability are discussed.

The Ups and Downs of Face Recognition:

A Unique Developmental Trend

Children's ability to recognize unfamiliar faces shows a most unusual developmental trend, see Figure 1. This curve has been found in both American children (Carey, 1978) and in my own work with Scottish children (Flin, 1980), and it raises two interesting questions.

(1) What aspects of face recognition are changing between 6 and 11 years to produce such a distinctive improvement in performance?

(2) Is the U shaped aspect of this curve peculiar to children's recognition of faces or does it extend to their recognition of non-facial stimuli?

Consider first the initial improvement in performance; what is the locus of these age differences? Results from a face matching and recognition task with children of 5 to 11 years are pertinent.

Study 1. This experiment was designed to measure relative cue salience of facial features and was based on an earlier study by Davies, Ellis and Shepherd (1977). There were eighty subjects, twenty of each age level 5, 7, 9, 11 years and approximately equal numbers of males and females in each group. The stimuli were black and white photographs of faces constructed from feature variants selected from the Male Caucasian Photofit Kit (Figure 2). Children were shown a target face, and then asked to select the same face from an array of six faces, five of which differed from the target by one feature component. Each subject was given 20 trials, 10 with the target face present (matching condition), and 10 with the target face absent (memory condition). However, there was no significant interaction found for Age X Delay (matching vs memory).

For each subject, total errors were recorded and subdivided into which of the 5 feature distractors had been selected instead of the target face. (The results of errors to specific feature variants are given in Flin (in preparation)). Figure 3 shows the mean error rates for the 4 age-groups and the two delay conditions (matching and memory). Performance was found to improve with age ($F(3,76) = 21.7$, $p < .01$). Older children of 9 and 11 years made fewer errors than both younger groups, 5 and 7 years (Tukey tests, $p < .01$). More errors occurred in the memory condition compared to the matching condition ($F(1,76) = 10.1$, $p < .01$).

The absence of an Age X Delay interaction suggested that the source of the age differences in this face recognition task was located at the initial encoding stage. The additional burden of storing and recognizing the information in the memory condition did not affect the developmental trend. These results question a previous finding by Sophian and Stigler (1981) who employed a very similar task, but found that an age related improvement in perceptual skill did not account for age differences in recognition memory. However, their data do show a number of ceiling effects which may have masked underlying developmental trends. The above conclusion that age differences are located at the initial acquisition stage concurs with contemporary theoretical accounts of memory development (e.g. Perlmutter and Lange, 1978).

Further support for an age-related change occurring at the acquisition stage comes from Carey's (1978) theory of the development of face recognition. She proposes that an encoding-switch takes place in face perception at 10 years of age. Young children encode piecemeal details whereas older children (>10 years and adults) rely on configurational information. The evidential basis for this argument comes from two sources a) the paraphernaha study (Diamond and Carey, 1977), and b) the inversion study (Carey, Diamond and Woods, 1980) which is examined here. Carey et al (1980), tested 6 and 10 year old children's recognition memory for upright and inverted faces. They found the normal improvement with age for upright faces, but no age difference for recognition of inverted faces. The 10 year olds showed the typical adult inversion effect, performance was compared to the inverted faces. But, the 6 year olds showed no inversion effect, their face recognition accuracy was the same for both orientations.

If we look at Carey's (1981) interpretation of these data, she has argued that, "As abstract meaningless patterns, inverted and upright faces do not differ and thus both present the same problems for an all-purpose pattern encoding mechanism". (Page 18). Thus, the age difference for recognition of upright faces cannot be accounted for in terms of general cognitive development as this would have produced a similar pattern of age effects for recognition of inverted faces. Instead, she proposes that the improvement from 6 to 10 years must be due to the acquisition of face-specific knowledge which can only be applied to upright faces. This knowledge is reflected in the ability to encode configurational information, rather than the piecemeal details on which young children base their recognition judgements. The older children show an inversion effect because they find it difficult to encode configurational information from inverted faces and must resort to piecemeal information. Hence the absence of an inversion effect for young children (their piecemeal encoding is less disrupted by inversion), and the lack of a developmental trend for recognition of inverted faces.

However, the complete absence of age differences from 6 to 10 years in a cognitive task of this nature is most unusual. Recent findings from Young and Bion (1980, 1981) suggest that the original data may have been contaminated by floor effects. They found that if either a very small set of stimulus faces were used, or if the faces were known to the subjects, then even the performance of young children (7 years) was disrupted by inversion. (Carey, 1981 also discusses the possibility of floor effects). Therefore, it is possible that these floor effects may mask both an inversion effect for children under 10 years of age and a developmental improvement for children's recognition of inverted faces. If so, this would have led to an underestimation of the contribution of general pattern encoding skills in the development of children's ability to recognise upright faces. This hypothesis was tested in the second study.

Study 2 To reduce the likelihood of floor effects, the face recognition test was made relatively easy by using small numbers of stimuli and long exposure durations at inspection (Forbes, 1975).

There were 271 subjects, comprising 12 groups of children, 2 classes (M size = 22) from each of the grades Primary 3, 6, 7; Senior 1, 2, 5. Mean ages of these groups were 7, 10, 11, 12, 13, 16 years respectively. There were approximately equal numbers of males and females in each class.

The stimuli were 40 black and white slides of boys' faces which had been photographed under uniform conditions. These were divided into 2 sets, each comprising 10 target and 10 distractor faces. The two sets of faces were counter-balanced across orientation at each age level. The upright face recognition test was given first for all groups. Children were shown the 10 target faces for 8 seconds each. Then the 20 randomly mixed target and distractor faces were displayed for 4 seconds each. The subjects were instructed to respond "old" or "new" for each face on a specially prepared response sheet. This test was followed by the inverted condition, instructions and procedure as above. Faces were inverted at both inspection and test phases.

For each subject hit and false alarm rates were scored and from these a d' score was calculated for upright and inverted faces. The mean scores for each age level are shown in Figure 4.

Subjects were better at recognizing the upright faces than the inverted faces ($F(1,265) = 528.0$, $p < .01$). At every age level children's d' scores were significantly higher for upright stimuli (t tests, $p < .01$). Thus, an inversion effect was found for children under 10 years of age (i.e. 7 years), as well as for older children, and this replicates the result obtained by Young and Bion (1980). It now seems quite apparent that the previous data on children's recognition of inverted faces may have been contaminated by floor effects.

Significant developmental trends were found for both recognition of upright faces $(F(5,259) = 10.16, P < .01)$ and inverted faces $(F(5,259) = 5.90, p < .01)$.

Hence, when floor effects are eliminated, children's recognition of inverted faces can be seen to improve with age. Following Carey's argument (above), the significant improvement in recognition of inverted faces suggests that age differences in general pattern encoding skills probably do contribute to the development of face recognition.

A significant interaction was found between age and orientation $(F(5,265) = 6.83, p < .01)$. This indicates that, alongside the development of general pattern encoding ability, some additional factor is contributing to the steeper developmental trend for recognition of upright faces. Carey (1981) calls this "knowledge of faces perse", however the very peculiarity of inverted faces makes them unsuitable as a baseline from which to assess the contribution of normal pictorial encoding skills to the face recognition process.

To return to the original question, what aspects of face recognition are changing between 6 and 11 years to produce the improvement in performance? First, the age differences in children's face recognition appear to be located at the initial acquisition stage, rather than at the later stages of storage or recognition. Carey (1981) has suggested that the development of configurational encoding is responsible for this trend. Young children encode piecemeal information whereas older children rely on configurational details. Children of 10 years and older show an inversion effect because their configuration encoding is orientation - sensitive. The inversion data reported here do not support this encoding - switch theory, as children younger than 10 years also showed an inversion effect. Thus if an encoding change takes place, it may be more subtle than Carey has suggested.

The growth of children's knowledge of faces is undoubtedly important for the development of memory for faces. However, one should not underestimate the potential contribution of more general pattern encoding and pictorial memory skills during the period of the early improvement in performance (7 - 11 years).

If we turn now to the observed regression at puberty, is this evidence that face recognition is subserved by a special mechanism? No similar dips have been reported for children's recognition in pictures. But, it is possible that previous studies of children's picture memory had missed the regression at puberty due to contamination by floor or ceiling effects or because of inadequate sampling of age groups. The third study examined whether the face recognition curve is unique, by testing children's (7 - 15 years) ability to recognize pictures of houses.

Study 3 Subjects (N = 142) were six classes of schoolchildren from Primary 3, 6, 7 and Senior 1, 2, 4. Mean ages of these groups were 7, 10, 11, 12, 13 and 15 years respectively.

From the slide library at Gray's School of Art, Aberdeen, 50 coloured slides of country houses were borrowed. These were selected for their similarity in terms of size, period of architecture and photographic presentation. They were randomly divided into 20 target and 30 distractor stimuli. Each target slide was shown for 2 seconds with an ISI of 1 second. During the test phase each slide was exposed for 4 seconds with 2 seconds between slides. Children were asked to respond 'old' or 'new' to each slide and from their responses a d' score was calculated for each child. The mean d' score for each age group are shown in figure 5.[1] (A mean adult score is appended for comparison, but this was not included in the analysis). There was a main effect for Age of Subject ($F(5,130) = 2.76$, $p < .05$), recognition accuracy improves between 7 and 12 years ($p < .05$) but declines from 12 to 13 years ($p < .05$) (Newman-Keuls tests). Thereafter, accuracy again improves, thus the developmental curve for recognition of pictures also shows a temporary decline at 13 years of age.

If one compares the developmental curves portrayed in Figures 1 and 5, a striking pattern of similarity can be seen. This indicates that the dip is related to the development of visual recognition memory, rather than a peculiarity of face recognition. Although there have been no previous reports of dips in recognition memory itself, there have been U-shaped curves described for problem-solving tasks involving mnemonic strategies across this age range (Somerville and Wellman, 1979; Weir, 1964). These temporary regressions are usually accounted for in terms of growth errors. That is, in the course of development, the child changes from one cognitive strategy (which has been well mastered) to a new and potentially more efficient strategy (which has not). During the transition period, when the child has relinquished the old strategy, but is not yet fully proficient with the new strategy, overall performance seems to be temporarily disrupted. The transition from crawling to walking is a good example of a growth error, during the changeover period the child's overall mobility is reduced. In the case of visual recognition memory, the child may be switching from encoding individual inputs separately to employing a formal classification system (such as prototypes) for categorizing incoming information. Alternatively, Diamond and Carey (1980) offer a maturational explanation for the dip in face recognition.

The incidence of U-shaped behavioural growth is not, however, restricted to the preadolescent period or to mnemonic tasks. Documentation of dips appears to be a new focus in developmental psychology, see Bever (1982) and Strauss (1982) for a broader discussion of this phenomenon. The lengthening catalogue of regressions in children's cognitive ability suggests that these dips and discontinuities may be an important key to understanding the basic processes of development.

Footnote:[1] Additional data from a pilot study with pictures of flags are also shown; although the trend is similar, no significant age effects were found.

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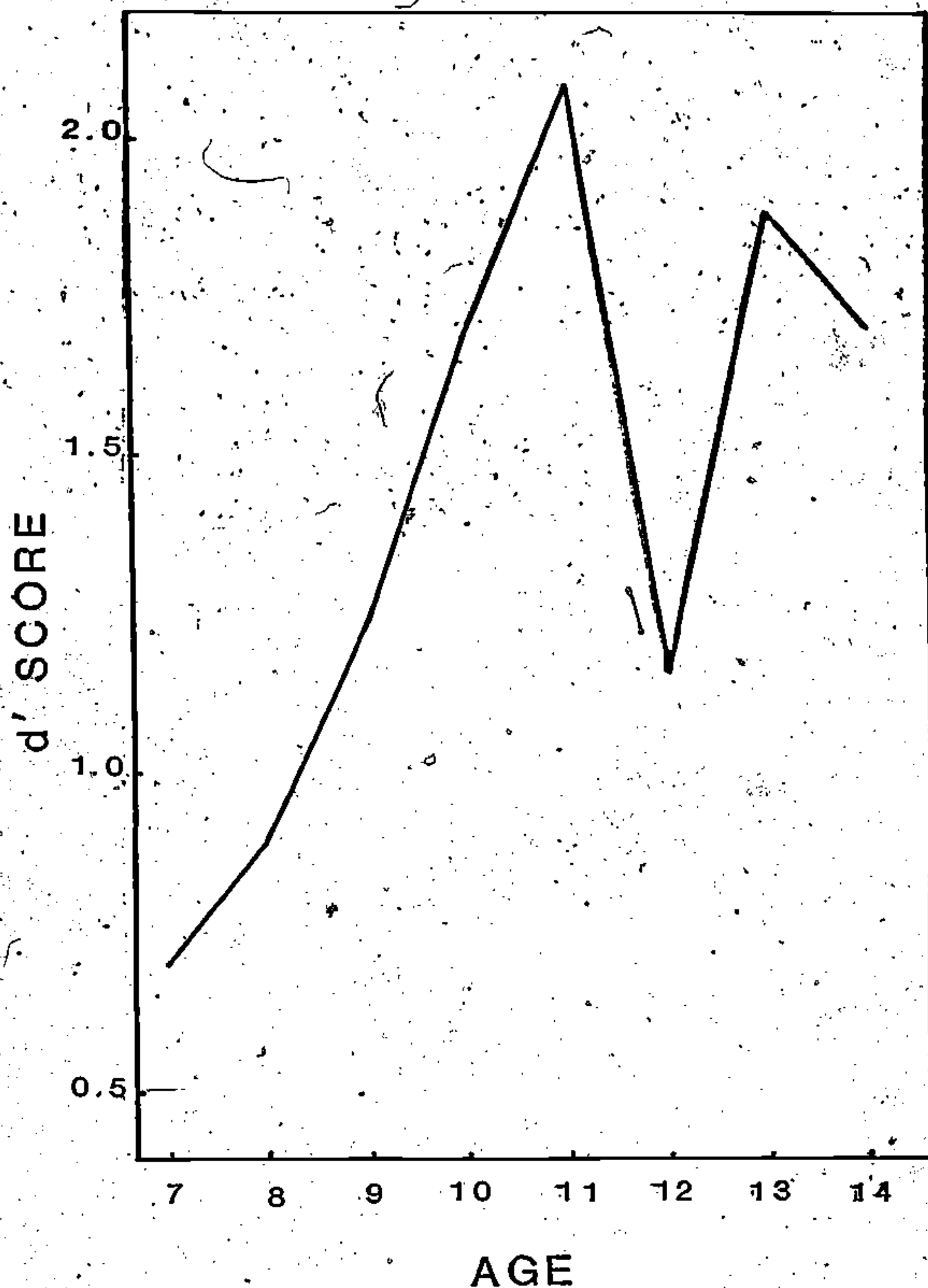

FIGURE 1 Recognition of Upright Faces

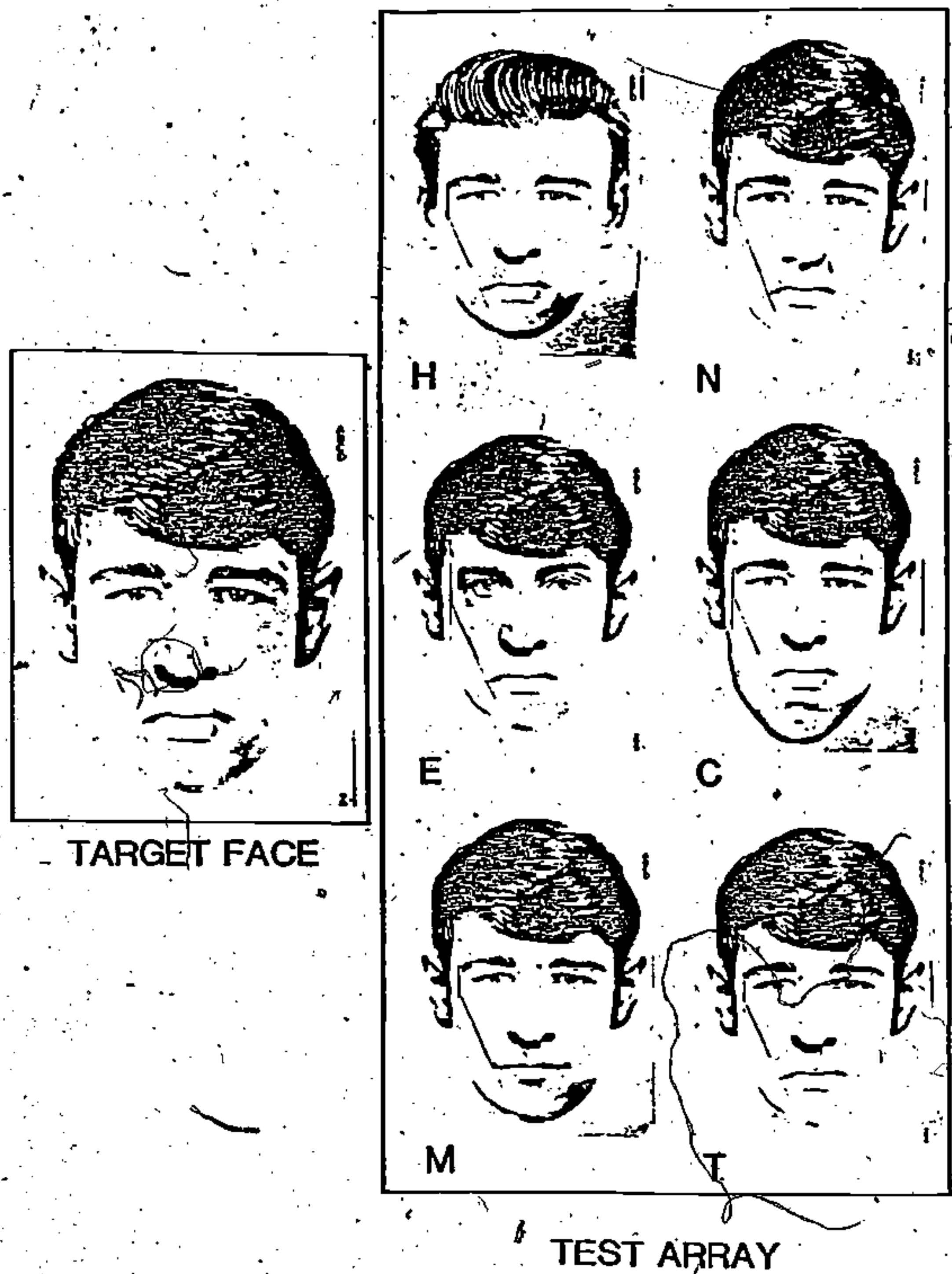

FIGURE 2 Example of Photofit stimuli

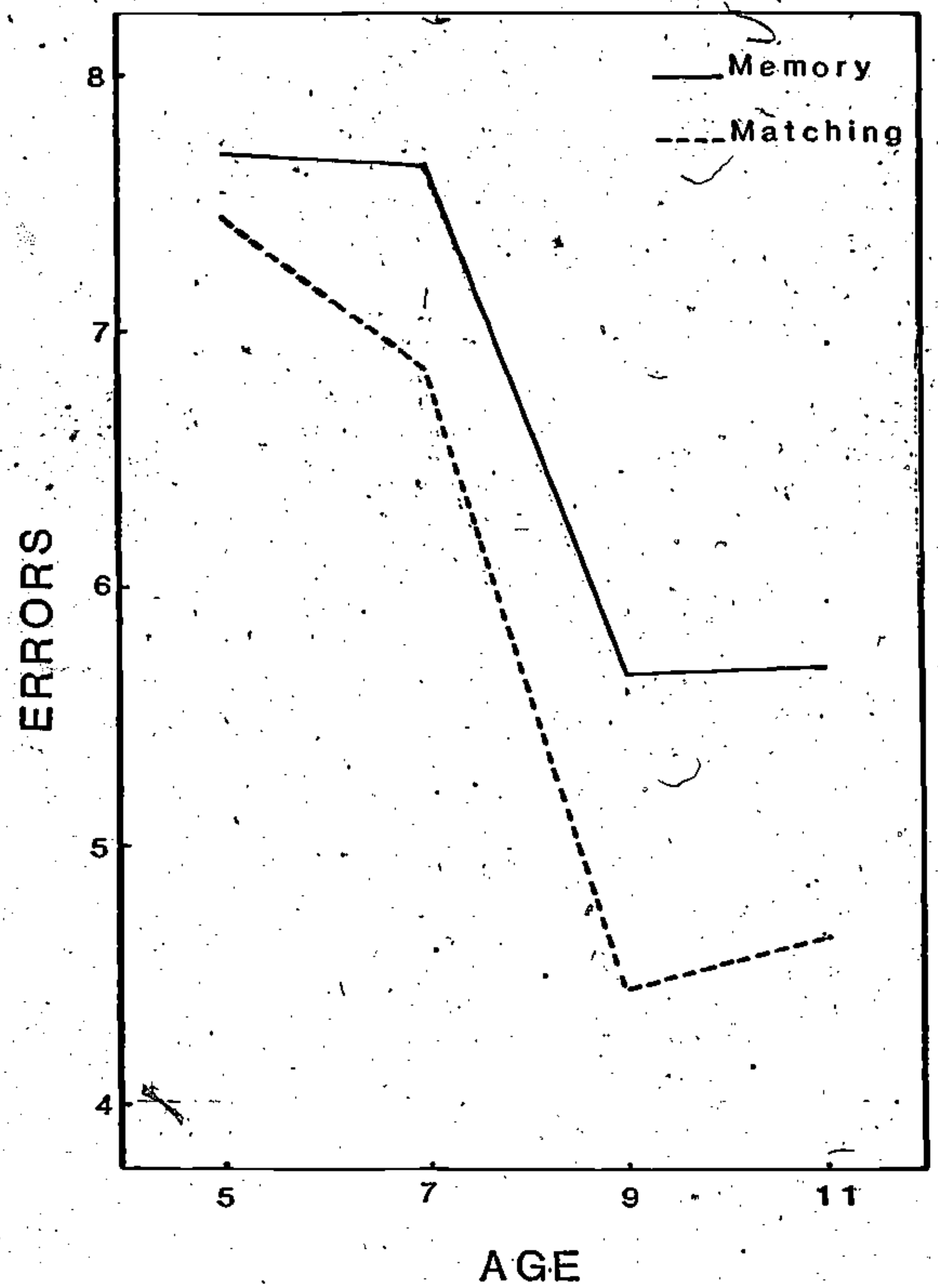

FIGURE 3 Matching and Recognition of faces

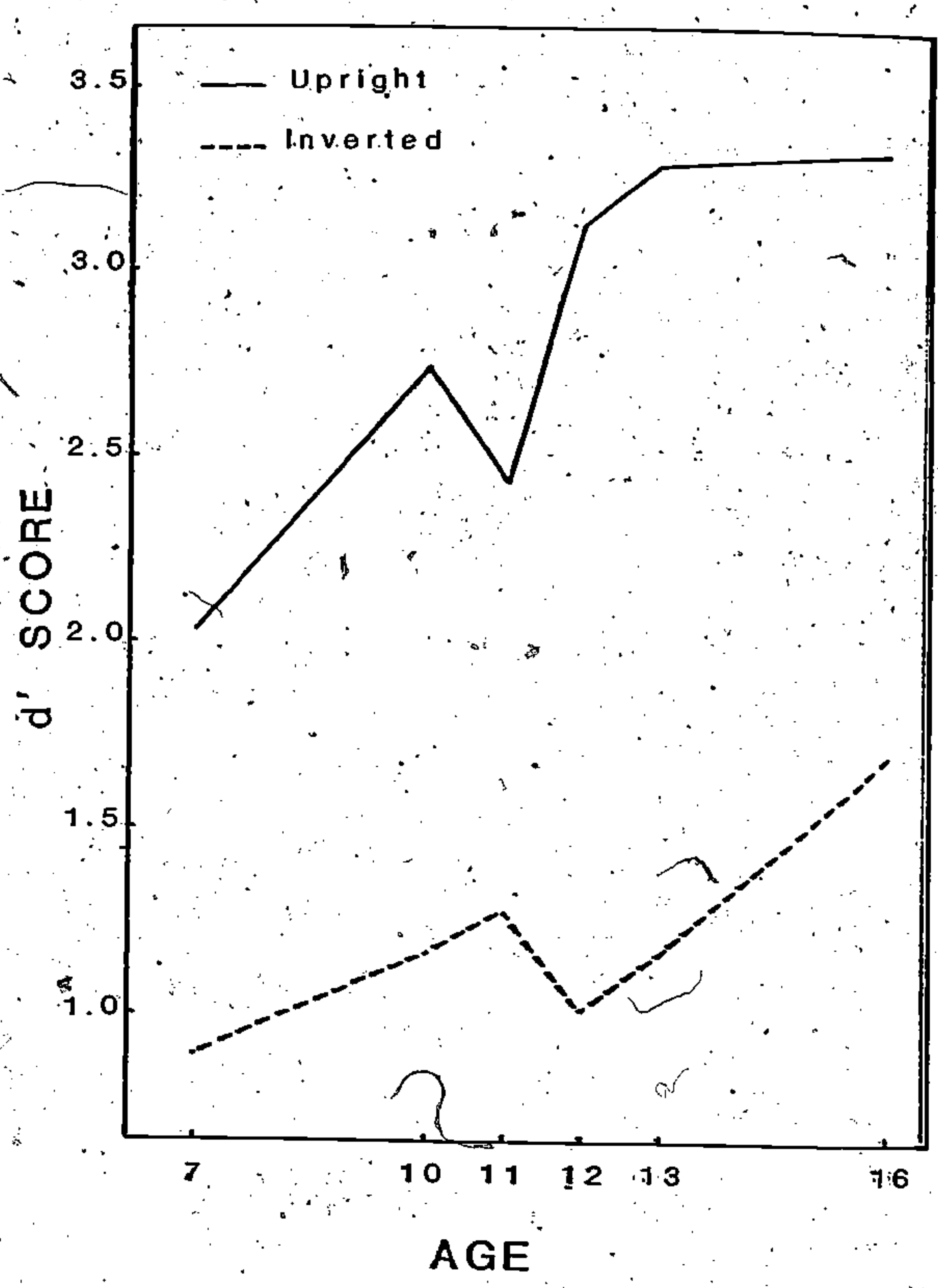

FIGURE 4 Recognition of faces

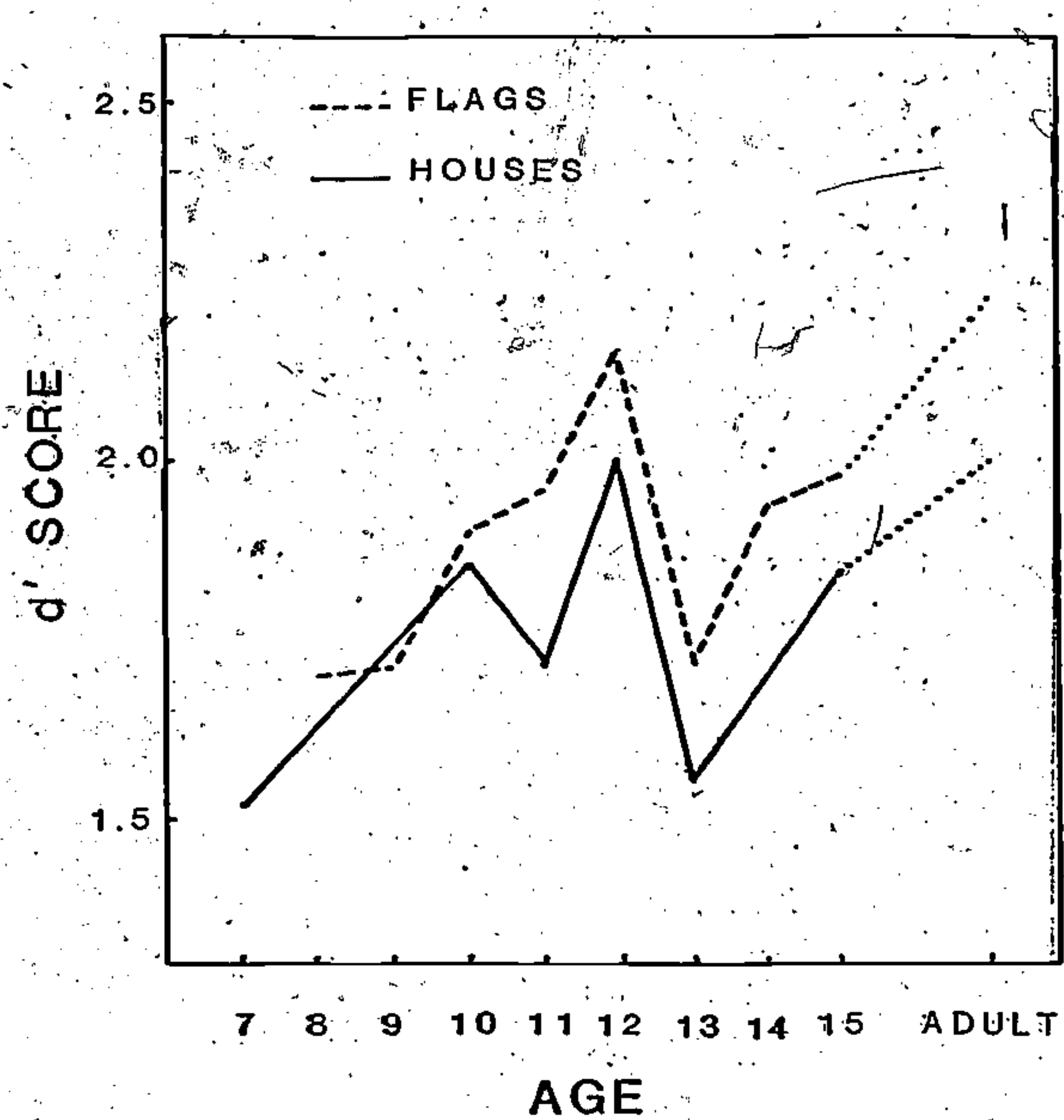

FIGURE 5 Recognition of pictures